



Compatibility of Types III/IV Gypsum with Addition Silicone Impression Material

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ABSTRACT

Background: Addition silicone is an elastomeric impression material used to obtain an accurate impression. Compatibility between impression material and gypsum will affect the surface quality of the resulting models. Types III and IV gypsum are very commonly used in dentistry to pour impressions and produce working models; despite this, there has been no further research regarding the differences between the two types in terms of compatibility with addition silicone impression materials. **Objectives:** To compare the compatibility of types III and IV gypsum with addition silicone impression materials. **Methods:** Gypsum compatibility was assessed on the basis of its ability to reproduce lines of certain widths. Thirty samples were produced by impressing a stainless steel ruled block (in accordance with ANSI/ADA Specification No. 19) with addition silicone (independent variable) and then pouring in type III or IV gypsum (dependent variable). The samples were divided into two groups: in Group A, addition silicone was poured with type III gypsum; in Group B, addition silicone was poured with type IV gypsum. The lines from the stainless steel ruled block that formed in the gypsum samples were observed with a microscope at 10x magnification. Each line was then assessed with a score from 1 to 4, according to Morrow's standardization, where a score of 1 indicates that the line was reproduced clearly and sharply over its entire 25 mm length, and a score of 4 indicates that the line is reproduced incompletely with roughness and/or blemishes. The data were analyzed using the Mann-Whitney U test. **Results:** Group B (addition silicone poured with type IV gypsum) produced more results rated as 1 (60% of the group's samples) than Group A (only 46.67% of the group's samples). **Conclusion:** On the basis of the number of scores rated as 1, type IV gypsum was more compatible than type III gypsum with addition silicone.

Keywords: addition silicone, dental gypsum, gypsum compatibility

Background

The surface texture of a cast fabricated from any dental impression material is crucial for diagnostic and treatment planning purposes, because it is the base from which diagnostic information is obtained, and the quality of the prostheses fabricated from the cast is higher.¹⁻⁵ Elastomeric impression materials, especially addition silicone (polyvinyl siloxane), have been reported as giving the most accurate results in terms of dimensional stability and surface reproduction. Addition silicone is used for accurate reproduction of hard and soft intraoral tissues.^{4,6} Dental stone produces working casts for forming dies and then fabricating cast restoratives (inlay, onlay, bridges, and partial and full dentures). Types III and IV gypsum are the most widely used filler materials for working casts.^{2,7} To date, however, there has been no research focusing on differences between types III and IV gypsum in terms of compatibility with addition silicone impression materials.

A standardized test to evaluate gypsum compatibility was conducted by Morrow and colleagues. A stainless-steel test block was used to compare the compatibility of different combinations of gypsum and impression. Etched lines 25 microns wide were inscribed onto the metal surface of the test block. The authors created a scoring scale from 1 to 4 to categorize the gypsum/impression combinations for compatibility. A score of 1 denoted a gypsum cast surface that reproduced the 25-micron line with the best detail and compatibility; a score of 4 denoted a gypsum cast surface with poor compatibility due to its lack of reproducibility. A light microscope at 10x magnification was used to evaluate all test samples.^{5,8-12}

The objective of this study was to compare the compatibility of types III and IV gypsum with addition silicone impression materials in accordance with American National Standards Institute/American Dental Association ANSI/ADA Specification No. 19.

Materials and Methods

The impression materials and dental gypsum were manipulated according to the manufacturer's instructions (Table 1). The addition silicone was manipulated using the dual viscosity/one-step technique. The testing apparatus consisted of four parts: the ruled block, the impression material mold, the riser, and the gypsum mold (Fig. 1). Samples were fabricated by taking an impression of the stainless steel ruled block in accordance with ANSI/ADA Specification No. 19.^{5,10,13}

The riser was used as a pad. The impression material mold was put on the riser as a container for the impression material. The ruled block, used as a master die, had three horizontal lines (0.075 mm, 0.05 mm, and 0.02 mm) and two vertical lines (both 25 mm) (Fig. 2). The gypsum mold was placed on the impression material mold and filled with gypsum.^{5,10,13} Thirty samples were obtained and divided into two groups: Group A consisted of the addition silicone impressions poured with type III gypsum, and Group B consisted of the addition silicone impressions poured with type IV gypsum. The lines produced were observed using a microscope at 10x magnification and then scored from 1 to 4 according to the standardization by Morrow (Table 2).¹³ The data were analyzed using the Mann–Whitney U Test.

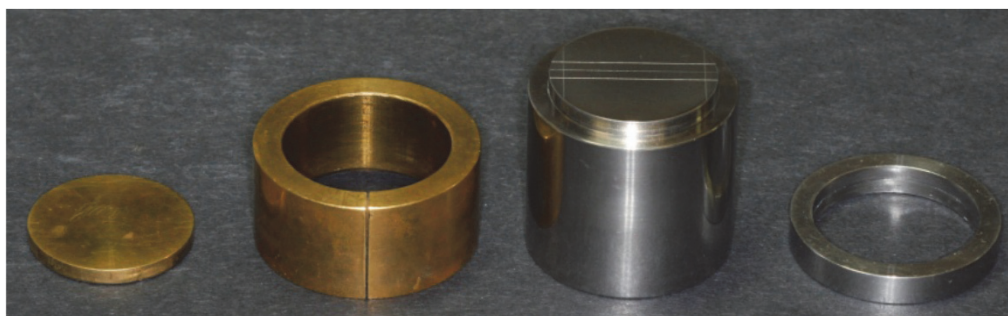


Figure 1. Test apparatus, from left to right: riser, gypsum mold, ruled block, and impression material mold.¹³

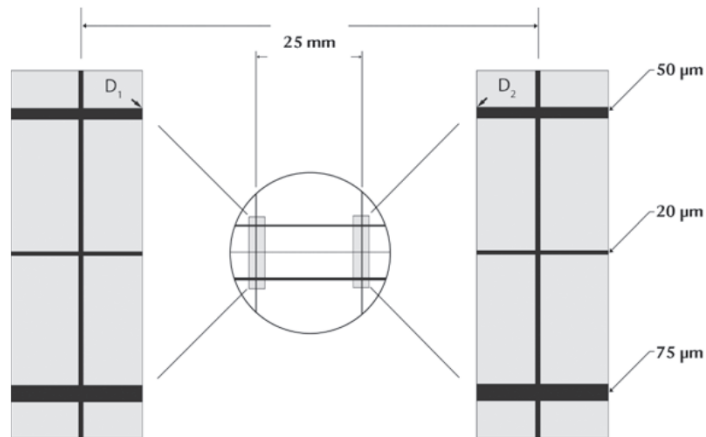


Figure 2. Schematic representation of ruled block surface.⁵

Table 1. Materials used in the study

Material	Producer	Composition	Lot Number
Exaflex Vinyl Polysiloxane Impression Material	GC Corporation, Japan	Heavy body: silicon dioxide, nonylphenol ethoxylated, methylhydrogen dimethylpolysiloxane Light body: silicon dioxide	Heavy body: 1611171 Light body: 1701161
Heraeus Kulzer Moldadur Dental Stone	Heraeus Kulzer GmbH, GrünerWeg 11, 63450 Hanau, Germany	Ammonium chloride, crystalline silica (quartz), calcium sulfate hemihydrate	4442141
Heraeus Kulzer Die Stone Peach	Heraeus Kulzer GmbH, GrünerWeg 11, 63450 Hanau, Germany	Ammonium naphthalene sulfonate, Portland cement, polyvinyl alcohol, plaster of Paris	4552151

Table 2. Scoring scale for the samples

Score	Description
1	The 0.02 mm line is reproduced clearly and sharply over its entire 25 mm length. This is the best appearance.
2	The 0.02 mm line is clear over more than 50% of its length (> 12.5 mm); it appears to be reproduced well over the entire length, smoothly but not sharply.
3	The 0.02 mm line is clear over less than 50% its length (< 12.5 mm), or visible over its entire length but blemished, rough, and/or not sharp.
4	The line is not reproduced over its entire length, and is rough, blemished, and/or pitted. This is the worst appearance.

Result

Each group consisted of 15 samples. The higher the score, the lower the compatibility level (Fig. 3). Samples from each group with scores of 1, 2, and 3 can be seen in Fig. 4. Figures A1 and B1 give the strongest indication of gypsum compatibility, as the lines are formed clearly and sharply over their entire length. Figures A2 and B2 show moderate degrees of compatibility, with one line clear over more than 50% of its length, and the other line

smooth but not sharp over its entire length. Figures A3 and B3 represent a still lower level of compatibility: although the lines are visible, they are rough and lack sharpness.

The Mann–Whitney U test indicated that there was no significant difference between the compatibility of types III and IV gypsum with silicone impression material ($p > 0.05$). Nonetheless, addition silicone filled with type IV gypsum yielded the best results in this study.

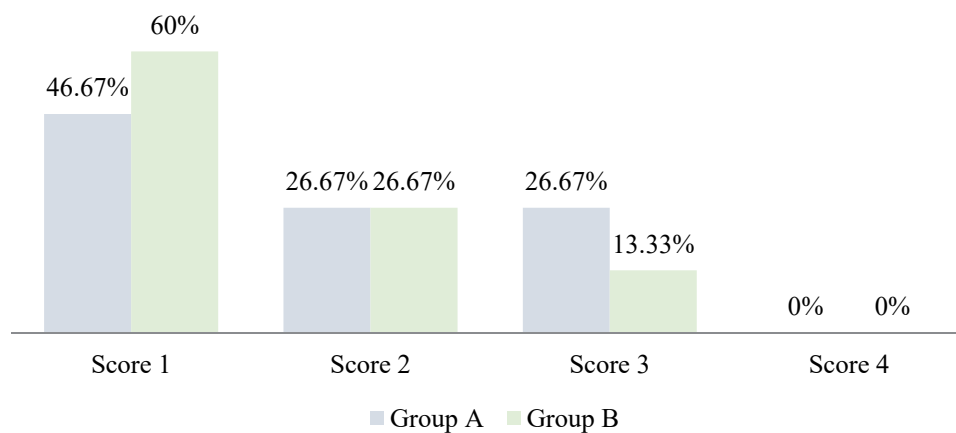


Figure 3. Distribution of compatibility scores between Groups A and B

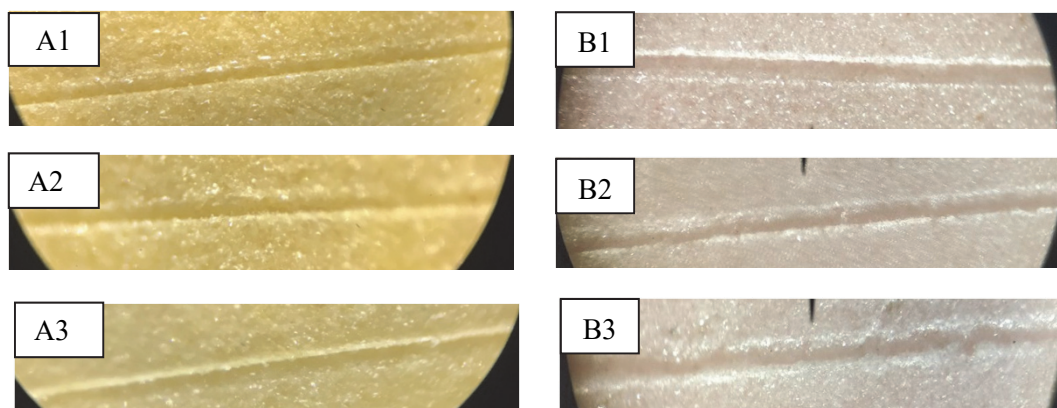


Figure 4. Samples observed using a microscope at 10X magnification. A1: from Group A, score 1. A2: from Group A, score 2. A3: from Group A, score 3. B1: from Group B, score 1. B2: from Group B, score 2. B3: from Group B, score 3.

Discussion

Types III and IV gypsum were tested to investigate whether certain specific combinations of impression material and gypsum yield a more accurate results than others. Material of the two types was used to fabricate test samples, and the researchers verified that the 20 micron line on the ruled block had been reproduced on the silicone impression before the gypsum was poured.

The results suggest that type IV gypsum was more compatible than type III with addition silicone. The manipulation of type IV gypsum requires less water than the manipulation of type III gypsum (the ratio is 0.3 g/mL for type III gypsum and 0.22 g/ml for type IV gypsum). Addition silicone is known to be hydrophobic. As type IV gypsum has a lower water content than type III, the hydrophobicity of the addition silicone may explain why it appears to be more compatible with type IV gypsum than with type III gypsum.^{6,14,15}

The possible link between hydrophobicity and compatibility gypsum with impression materials can be explained as follows. Type III gypsum (dental stones) is produced when gypsum is dehydrated under pressure and in the presence of water vapor at about 125°C (wet calcination). Calcium sulfate hemihydrate produced in this manner is designated as hydrocal and is used in making low to moderate strength dental stones.^{2,7,16} Type IV gypsum (high strength) is produced when the gypsum rock is boiled in a 30% calcium chloride solution, after which the chloride is washed away with hot water (100 °C). The resulting product is called densite, and the material is ground to the desired fineness (in the presence of water at 100 °C, calcium sulfate hemihydrate does not react to form calcium sulfate dehydrate, because at this temperature they have the same solubility) The powder obtained from this process is the densest of the types. While the dense of gypsum's particles increase, the reproduction of the gypsum is getting more meticulous.

The findings of the present study indicate that type IV gypsum produces better detail surface than type III gypsum.^{2,7,16} However, the study found no significant difference between type III and type IV gypsum in terms of compatibility with addition silicone. This is in line with previous studies (including those from 2010 and 2011 by

Scheller-Sheridan and by Hatrick and Eakle, respectively) that found addition silicone to be compatible with gypsum products generally.^{6,11,12}

The impression materials tested here may perform differently in vivo. For example, addition polymerized silicones are hydrophobic in nature, and manufacturers add surfactants to enhance the hydrophilic characteristics of the material.^{4,5,6} Therefore, in moist oral conditions, these impression materials may display different properties than those identified in this study. They may also be affected by oral fluids such as blood and saliva. Future research should be directed toward investigating gypsum compatibility in oral conditions.

Conclusion

Gypsum products were evaluated for compatibility with a specific brand of addition silicone impression material. Within the limitations of this study, there is evidence that type IV gypsum may be more compatible than type III gypsum with the addition silicone, and this possibility is worth exploring in future research.

Conflict of Interest

The authors declare that there are no conflict of interest.

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